stations within or near the border of the respective States, as indicated below; and (*c*) the growing season weather data, as hereafter named, for the respective States. For phase (*c*), data relating to rainfall, number of cloudy days and number of rainy days are respective State means for all Weather Bureau stations maintained in the respective States, while the sunshine and relative humidity data are for the first-order stations named for each State. The relative humidity data are the means for the noon and post meridian observations. In the following summary the details of computations are omitted and only the constants applicable to the several phases for computing the weevil indices given:

DATA USED FOR REVISED WEATHER-WEEVIL COMPUTATION

(The *a* and *b* phases are the same for all States, as before indicated)

North Carolina.—Weather data (*c*) percentage of possible sunshine, June to August, inclusive. First-order stations Charlotte, Raleigh, and Wilmington, N. C., and Norfolk, Va. The constants, $+0.25b$; $-1.53c$; $+10.9$. (Phase "*a*" not used, because of shortness of record.)

South Carolina.—Weather data (*c*) percentage of possible sunshine, July and August, combined. First-order stations Charleston, Columbia, and Greenville, S. C., Augusta, Ga., and Charlotte, N. C. The constants, $+0.20a$; $+0.67b$; $-1.41c$; $+99.0$.

Georgia.—Weather data (*c*) relative humidity July and August, combined. First-order stations Atlanta, Augusta, Macon, and Thomasville, Ga. The constants, $+0.44a$; $+1.35b$; $+1.88c$; -132.9.

Alabama.—Weather data (*c*) relative humidity, July and August, combined, and (c_1) August rainfall. First-order stations, Birmingham and Montgomery, Ala., and Meridian, Miss. The constants, $+0.46a$; $+0.57b$; $+0.99c$; $+1.28c_1$; -66.1.

Mississippi.—Weather data (*c*) number of cloudy days, April to August, inclusive; (c_1) relative humidity, July and August, combined. First-order stations Meridian and Vicksburg, Miss., and Memphis, Tenn. The constants, $+0.24a$; $+0.51b$; $+0.38c$; $+0.75c_1$; -52.4.

Tennessee.—Weather data (*c*) rainfall July and August, combined. First-order stations Memphis and Nashville, Tenn., and Cairo, Ill. The constants, $+0.52a$; $+0.62b$; $+0.88c$; -41.1.

Louisiana.—Weather data (*c*) rainfall June and July, combined; (c_1) relative humidity, June to August, inclusive. First-order stations Shreveport, La., and Vicksburg, Miss. The constants, $+0.30a$; $+0.19b$; $+1.14c$; $+0.39c_1$; -27.3.

Arkansas.—Weather data (*c*) number of rainy days, June and July, combined. First-order stations Fort Smith and Little Rock, Ark., and Memphis, Tenn. The constants, $+0.43a$; $+0.40b$; $+1.27c$; -16.5.

Oklahoma.—Weather data (*c*) rainfall, June and July, combined. First-order stations Oklahoma City, Okla., and Fort Smith, Ark. The constants, $+0.32a$; $+0.63b$; $+4.48c$; -25.2.

Texas.—Weather data (*c*) rainfall, June and July combined; (c_1) relative humidity, June to August, inclusive. First-order stations Abilene, Amarillo, Fort Worth, Palestine, San Antonio, and Taylor, Tex., and Shreveport, La. The constants, $+0.31a$; $+0.75b$; $+1.19c$; $+0.32c_1$; -23.8.

CONCLUSIONS

In the matter of application of the results of this study to future years for an early indication of cotton production, it may be pointed out that practically all data are available soon after the close of August for a current growing season. The compilations in full, including the combined weather-weevil determinations, and the weather-yield correlations for the 10 States, comprise some 75 independent variants, covered into the final results through 20 separate equations, but only 1 contains more than 4 variants. None of the data, except September rainfall in North Carolina, extends later in the season than August.

In case application of results is desired before the North Carolina September rainfall becomes available, this may be approximated by using the average rainfall for that month. In such case, because of the large number of variants used, the error would be negligible, as a rule. For example, by using the North Carolina average September rainfall, instead of the actual, for the 20-year period covered by this study, the results would differ from those obtained by using the actual rainfall by an average of less than 0.3 of 1 per cent, with a maximum difference of only 1 per cent, notwithstanding September rainfall in North Carolina varied during the period from 1.2 inches to 11.2 inches. This is a striking indication that the methods used in these computations give a stability in results much greater than is usually found in weather-crop correlation work, which inspires confidence as to its satisfactory future application.

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METEOROLOGY AND ITS IMPORTANCE TO AVIATION

By W. J. HUMPHREYS

Some knowledge of the air and its ways obviously is essential to both the science and the art of aerial navigation. It does not follow, however, that all who are concerned with this science and this art need to know exactly the same things about the atmosphere, nor to know them in exactly the same way. The designer of the engine must know the composition and density of the atmosphere at all levels at which the machine is supposed to operate, since these are essential factors in the determination of the power available, but he does not need to know much about the theory of turbulence, skin friction, stream lines, and the like. These vitally important matters concern, most of all, the designers of the wings and the fuselage. Finally the aviator, though his very life depends on somebody's knowledge of these things, does not often himself bother about them. He would be bored beyond endurance by the exact observations, experiments, "high-brow" theories, and tedious calculations they require. His is the active, impatient spirit that wants to be up and flying. He would rather fly a "barn door" right away than hang around a month or two waiting for the finest product the laboratories can produce. Neither does he care to know, nor much need to know, the technical terms and long equations which the meteorologist uses in his discussions of wind and weather. He takes his machine, engine, wings and all, as prepared by others, and he wants the prediction of the weather the same way—handed to him on a platter, as it were. And in the main his wishes are entirely reasonable. Nevertheless, while in the air and on making a forced landing the aviator has to be very much "on his own," as we say. At such times a working knowledge of the machine and a practical understanding of the atmosphere are essential to his success.

But to be specific; exactly what knowledge of meteorology does the aviator really need, when there is a specialist at every airport to tell him what the weather is along the route he is about to take, and what it is expected to be at every mile of the way? Well, he needs at least enough knowledge of meteorology to enable him to read a weather map understandingly; enough to enable him to discuss this map intelligibly with the man who makes the forecasts for him; enough to enable him to judge, while in the air, whether or not the forecasts are coming true; and enough to give him an understanding of the weather significance of the clouds and the look of the sky. From his study, with the aid of the forecaster, of the latest weather map, constructed from extremely recent observations along and on either side of the route to be flown, he learns what sort of weather to expect at each particular place and time. But weather does not always come exactly according to the forecast. It therefore is essential that the aviator know not only what kind of weather he probably will encounter, and where, but also he must definitely understand the significance of the clouds and other weather appearances and their relations to the anticipated weather. He must know to a certainty from the looks of things whether the expected storm, for instance, is developing sooner than anticipated, or later. In short, in addition to being able to consult intelligently with the station meteorologist and read knowingly the weather map, he must be able to visualize that map in terms of actual weather phenomena, and especially must he become weatherwise for the route he is flying, just as the fisherman is weatherwise in respect to his own home waters.

The station meteorologist must know all the aviator does about the atmosphere and a good deal besides. He must be an expert short range—three to six hours—forecaster for his region. He also should have at least a working knowledge of theoretical meteorology, including, of course, the physical processes involved. This additional knowledge will not only make him a better forecaster but likewise increase his value as a consultant.

In addition to the above there also are a number of facts about the atmosphere the aviator should know. The station meteorologist should know them, too, in fact he should know nearly all that is known about meteorology, or, at least, have at hand the best books on the subject—English, French, and German, including the mathematics and physics—and know how to look up at a moment's notice anything that is in them. But to return to what the aviator should know.

STRUCTURE OF THE ATMOSPHERE

He should know that the atmosphere has structure, both general and detailed. He should know, for instance, that from the surface of the earth up to the height of 6 or 7 miles, in middle latitudes, the temperature decreases at the average rate of about 1° F. for each 300 feet increase of level, though near the surface the the rate varies widely and often is even reversed, as will be explained presently. This extensive portion of the atmosphere is called the troposphere; that is, the turning-over or convectional region. This is the region of turbulence and eddies, especially near the ground, of vertical convection, of clouds and of storms. Above it in that region we call the stratosphere—the aviator's paradise, if his machine were adapted to it—there is no appreciable turbulence of any kind, and never a cloud to smore the sun, blink the stars, or drag him down with a load of ice. In many respects this serene stratum of the atmosphere is ideal for long flights in high latitudes.

Of course, though, no matter how long one might be able to fly at this great height he must have started from the ground and eventually must come back to the ground, and in so doing pass through the surface layer that so frequently is turbulent. Usually this turbulence means nothing worse than a few bumps that may remind one of riding over cobblestones; but occasionally it means a great deal more, especially to the beginner and the incautious, for the eddies that make these bumps have also caused many a disastrous side slip when the turning was sharp and the banking steep. The method of prevention is obvious—don't be in such a hurry, take a wide curve and bank gently until a considerable height has been attained.

Not only must the aviator take off from the surface and land on the surface, but his place of landing is not always an airport, properly located and fully equipped. In all such cases it is well to avoid, after sundown, the lower end of any steep valley or canyon, especially if it happens to be treeless and covered with snow. This is because cold surface air (and where there is no general wind the surface air gets much colder after sundown than does the air some distance above) drains away to lower levels, and under favorable circumstances, such as those just mentioned, frequently develops into a veritable torrent.

And there is one more place the prudent aviator will shun—the heart of the thunderstorm. In it there are two dangers, the danger of being struck by lightning and the greater danger of being wrecked by violent winds. Some aviators emulate Tam O'Shanter by not minding the storm a whistle, but it should be recalled that on that memorable night Tam was gloriously drunk.

SOARING

The sport of soaring is now in the air, literally and figuratively. Soaring is tobogganing down an upflowing wind just as surf riding is tobogganing down the front and rising side of a traveling wave. Supporting breezes are above the crest and on the windward side of every hill and mountain, beneath the forward portion of the cumulus cloud, and even over the waves of the ocean, as the matchless albatross unwittingly reveals. But except in the case of the cumulus cloud these supporting currents are rather shallow, and dependent entirely on the direction and intensity of the surface winds. To this branch of aviation therefore an understanding of the air and its ways is not only helpful, as it is to all kinds of aerial navigation, but absolutely essential.